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Type of Organization: College or University

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Project Title: Impacts of zebra mussels on Great Lakes ecological dynamics

Project Category: Exotic Species

Rank by Organization (if applicable): 0

Total Funding Requested (\$): 207,885 **Project Duration:** 2 Years

Abstract:

Zebra mussels, *Dreissena polymorpha*, have changed Great Lakes' ecology through their ability to alter benthic and pelagic communities. These alterations have necessarily resulted in major changes of community function that have impacted material-energy transfer in aquatic food webs of these systems. This study proposes to build upon a significant database of descriptive ecology developed by the EPA research cruises and others during the last 20 years. These historical descriptive data (describing community structure) will be integrated with contemporary data from the proposed study to develop the functional interactions that describe community material-energy exchanges. Specifically, stable isotopes ($\delta^{15}\text{N}$ and $\delta^{13}\text{C}$) will provide a detailed analysis of the benthic and pelagic components of the food web, suggesting how *D. polymorpha* has altered energy flow in these systems. Second, pre-zebra mussel era production estimates (an energy flow term) of *Diporeia* will be compared to post-zebra mussel era *Diporeia* production rates measured in the proposed study. Examination of these functional trophic interactions will allow a needed assessment of the impact of zebra mussels, particularly on *Diporeia* populations that are now known to be collapsing in some regions of Lake Michigan.

Geographic Areas Affected by the Project**States:**

<input type="checkbox"/> Illinois	<input type="checkbox"/> New York
<input type="checkbox"/> Indiana	<input type="checkbox"/> Pennsylvania
<input checked="" type="checkbox"/> Michigan	<input checked="" type="checkbox"/> Wisconsin
<input type="checkbox"/> Minnesota	<input type="checkbox"/> Ohio

Lakes:

<input type="checkbox"/> Superior	<input type="checkbox"/> Erie
<input type="checkbox"/> Huron	<input type="checkbox"/> Ontario
<input checked="" type="checkbox"/> Michigan	<input type="checkbox"/> All Lakes

Geographic Initiatives:

<input type="checkbox"/> Greater Chicago	<input type="checkbox"/> NE Ohio	<input type="checkbox"/> NW Indiana	<input type="checkbox"/> SE Michigan	<input type="checkbox"/> Lake St. Clair
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Primary Affected Area of Concern: Not Applicable**Other Affected Areas of Concern:*****For Habitat Projects Only:*****Primary Affected Biodiversity Investment Area:****Other Affected Biodiversity Investment Areas:****Problem Statement:**

Throughout the Great Lakes, a growing concern centers on what functional ecological changes in the benthic communities are occurring as a result of increasing *D. polymorpha* abundance. Although many studies have examined the numeric abundance of community organisms in soft bottom substrates, very little is known on how *D. polymorpha* has impacted the ecological dynamics of the benthos, especially with regard to trophic interactions and secondary production. This is of fundamental importance if we wish to expand our understanding from the descriptive ecology of communities to the functional ecology that provides rate data on material-energy flow through the community. A major impact of *D. polymorpha* is the shunting of C flow in food webs from the pelagic zone to the benthic zone, which has serious implications not only on the diagrammatic structure of food web (who is eating what) but also on cycling rates in these lakes. A current problem believed to be related to the introduction of *D. polymorpha* into the Great Lakes, is the dichotomy occurring in the inshore and offshore waters, with increasing *Echinogammarus* populations in the former, and decreasing *Diporeia* populations in the latter. We propose to use stable isotopes ($\delta^{15}\text{N}$ and $\delta^{13}\text{C}$) in a detailed analysis of the aquatic food web in the southeast area of Lake Michigan and at shallow and deep sites adjacent to Milwaukee in the southwest area of Lake Michigan. The SE area of Lake Michigan has been chosen since the decline of *Diporeia* and the increase of *D. polymorpha* has been well documented (Nalepa et al, 1998). The SW area of Lake Michigan was selected since it provides an important historic pre-zebra mussel database on *Diporeia* secondary production (Lubner, Ph. D. thesis 1979). The SW site production data will have an important bearing on whether zebra mussels might be implicated in the *Diporeia* decline at the SE site. That is, if in the SW site zebra mussel occurrence positively corresponds with a decline of *Diporeia* production, then the present collapse of *Diporeia* in the SE of Lake Michigan would be highly suspect to be related to occurrence of zebra mussels. Production measures are sensitive indicators of a changing ecology (more so than abundance or biomass).

Proposed Work Outcome:

We propose to take our understanding of the effects of *Dreissena polymorpha* on Great Lakes ecological processes to the next level. By integrating stable isotopes and secondary production rates into descriptive ecological parameters collected by the EPA and other researchers, we will broaden our view on how the zebra mussel has impacted material-energy cycling within the Great Lakes. This information will then be used to suggest to what extent this has affected native fauna (such as the amphipod *Diporeia*). The outcome of this project is to develop a holistic synthesis of the soft substrate community by integrating several research areas. These research areas are as follows.

Analysis of the Aquatic Food Web

The stable isotopes of nitrogen and carbon will be used to analyze the aquatic food web in the southern basin of Lake Michigan. Various organisms for stable isotopic analysis will be sampled in the pelagic and benthic zone using replicate plankton net tows and ponar grabs respectively. Samples will be collected from a ship once a year for two years at a predetermined site in the SE area of Lake Michigan and two predetermined sites (nearshore and offshore) in the SW area of Lake Michigan. Trophic interactions determined through stable isotopic signatures will be used with data from the EPA and other researchers to establish successive changes in trophic pathways over the past two decades. The two-year period is recommended to minimize temporal variability in C and N isotopic signatures and allow greater accuracy of secondary production estimates.

Benthic Secondary Production Estimates

Benthic secondary production estimates will also be made at the above sampling sites. In order to obtain an accurate measurement of production rates, sites will be visited six times throughout the year for a period of two years. Organisms will be sampled through replicate ponar grabs and production rates will be determined for the dominant organisms based on size and weight relationships. Production rates will be coupled with trophic interactions (who is eating what) to estimate trophic material-energy transfers in the contemporary food web (how much is available to be eaten). Production rates of the amphipod *Diporeia* will also be compared to historic, pre-zebra mussel production rates to determine if the current *Diporeia* decline is related to zebra mussel prevalence (production at SW and SW sites and associated zebra mussel abundance data.)

Other Issues

The two-year data set obtained from the two SW sites will be made available to the EPA's ongoing invertebrate monitoring program. This portion of Lake Michigan is not currently included in the EPA's data set. Sampling at these stations will also document the presence or absence of the ponto-caspian *Echinogammarus*, in the southern basin of Lake Michigan. Populations of this recent invader have been reported in Lake Erie and Lake Huron.

Project Milestones:**Dates:**

Field Sampling for 1st yr	09/2000
Stable Isotopic Analysis for 1st yr	07/2001
Secondary Production Analysis for 1st yr	08/2001
Field Sampling for 2nd yr	09/2001
Stable Isotopic Analysis for 2nd yr	07/2002
Secondary Production Analysis for 2nd yr	08/2002
Final Data Analysis	09/2002
Final Report	12/2002

☐ Project Addresses Environmental Justice

If So, Description of How:

☒ Project Addresses Education/Outreach

If So, Description of How:

Conference presentations and peer reviewed publications will be an outcome of this project.

Project Budget:

	Federal Share Requested (\$)	Applicant's Share (\$)
Personnel:	67,000	7,500
Fringe:	5,575	2,438
Travel:	2,000	0
Equipment:	0	0
Supplies:	8,500	0
Contracts:	0	0
Construction:	0	0
Other:	82,000	3,960
Total Direct Costs:	165,075	13,898
Indirect Costs:	42,810	4,570
Total:	207,885	18,468
Projected Income:	0	0

Funding by Other Organizations (Names, Amounts, Description of Commitments):

If an EPA vessel or NOAA's RV Shenehon are available for this project, the ship time included in OTHER would be significantly reduced (a decrease of approximately \$70,000).

Description of Collaboration/Community Based Support:

This project is a collaborative effort between the University of Wisconsin at Milwaukee's W.A.T.E.R. Institute and NOAA's Great Lakes Research Laboratory in Ann Arbor, Michigan.